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REPORT OF THE DIRECTOR

For the Year Ending October 31, 1943

Connecticut
Agricultural Experiment Station
New Haven

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(As of October 31, 1943)

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Jack Yavener, *Technician*
Dorothy Lenard, *Secretary*

[1] On leave
[2] On military leave
[3] In cooperation with the U.S.D.A.

CONTENTS

PAGE

INTRODUCTION 43

Events at the Station 43

War Gardens 44

The Staff 44

PROGRESS OF THE STATION'S WORK 47

Entomology 47

Plant Pathology and Botany 52

Genetics (Plant Breeding) 56

Soils 59

Forestry 63

Tobacco Substation 66

Analytical Chemistry 69

Biochemistry 70

Biometry 73

THE LIBRARY 74

LIST OF PROJECTS 75

LIST OF PUBLICATIONS 78

REPORT OF THE TREASURER 81

FIGURE 1. Field Day at Mount Carmel Farm.

REPORT OF THE DIRECTOR

FOR THE

YEAR ENDING OCTOBER 31, 1943

To the Board of Control of the
Connecticut Agricultural Experiment Station:

This is written at the end of our second year of war. An undercurrent of optimism on the military situation is widespread—perhaps it may be over-optimism. Whether this is wishful thinking is not for us to say. Our task is to serve agriculture and aid in the solution of its problems. And when one turns to our farms, he finds a confused situation. In some cases, in spite of unavoidable handicaps, farmers have not fared too badly. True, they have worked unbelievably hard. The story of their struggle matches the romantic tales of the pioneers. But in other cases, and in certain types of farming, the returns have been less satisfactory.

However, on all farms, the basic need exists and is magnified by the war—the need for greater efficiency. If four sprays will give the same control of pests as six, much labor is saved. If a new hybrid corn adds five bushels to an acre, all society, as well as the farmer, may count the gain. This, as always, is the Station's guiding principle.

In spite of preoccupation with the day's troubles, farmers like all citizens, are looking ahead to the post-war years. What lies beyond the horizon? How can we plan to meet changes that may come? Here too the Station should be prepared with the best information possible to provide. Without attempting to predict the future, we can, and are making a definite effort to be ready. The State Post-War Planning Commission under President Seymour's leadership is now organized. The Station is represented on the Subcommittee for Agriculture. This offers an ideal road to desirable coordination.

This brief account of the year's effort is not a complete record. That will appear in the bulletins and circulars issued from time to time and later assembled into the complete Report.

EVENTS AT THE STATION

Open House in September

Some 400 visitors attended the Station's Open House on September 8. A departure from the traditional Field Day at the Mount Carmel farm, the event was held on the Station grounds.

Montague Free, Horticulturist of the Brooklyn Botanic Garden, was guest speaker. Both before and after his address in the auditorium of Britton Laboratory, guests had the opportunity to visit Station laboratories and greenhouses where staff members were on hand to answer questions. Many guests brought basket lunches and took advantage of the Station's invitation to gather at the tables and have coffee.

A "Victory Garden Clinic", one of the features of Open House, drew a steady stream of home gardeners with questions on vegetable varieties, plant pests and soil conditioning. Special exhibits included the wood-burning furnace unit, Japanese beetle control, blight resistant chestnuts, new corn and vegetable varieties developed by the Station, and non-parasitic plant diseases. Moving pictures on mosquito control and white pine blister rust were shown.

Registration showed that home gardeners outnumbered other groups at Open House. Next came farmers. Editors, public and park officials, seed firm representatives and other professional gardeners completed the attendance.

New England Vegetable Growers

Growers, plant breeders and county agents attended a two-day conference of New England Vegetable Growers here on February 2 and 3. The first day's program was devoted to a series of technical discussions on vegetable culture. The following morning reports of the discussions were given for the benefit of farmers, seedsmen and others. The total attendance of 65 represented all the New England States but Maine.

Federated Garden Clubs' Day

Because the staff found it necessary to curtail speaking engagements this season, "A Day at Your Experiment Station" was inaugurated by the Federated Garden Clubs of Connecticut. Each club was invited to send two delegates to the event, which was held on March 3 in Britton Laboratory. The morning meeting gave the visitors a chance to catch up on the latest developments in pest control, soil fertilization and other phases of gardening, and to ask questions of the group of staff members who were present. Director Slate addressed the afternoon session which ended in a tour of the laboratories. Although the day broke with a bad snow storm, 84 members attended. The "school" was arranged by Mrs. John B. Wallace, chairman of the Federation's program committee.

Other Station Events

The Station was host to a number of agricultural groups during the year. The Connecticut pest control operators met here on January 26; the State Nurserymen's Association, on March 10.

The Federated Garden Clubs held their annual all-day meeting here on October 8. Louis Bromfield, author and Pulitzer Prize winner,

addressed the group on "Soil Conservation". The morning session was devoted to annual reports and election of officers. Mrs. Charles O. Miller, president, presided at the meetings.

Britton Auditorium was used by the New Haven Garden Club on two occasions—for its annual meeting on June 14, and for its victory garden products show on September 28, in which Station staff members participated as judges.

On January 23 the Connecticut Editorial Association held its annual meeting in Britton Auditorium.

WAR GARDENS

In common with other agencies the Station staff gave largely of its time to this important program. Some served on local and state committees. Many talks were given to town and community groups. Particularly useful was Circular 155, "Controlling Pests of War Gardens". Addressed to home gardeners, this circular was the outcome of our many years of research on commercial food crops. Forty thousand copies were distributed on request.

THE STAFF

Military Leaves

Fifteen members of the staff are now serving in the Armed Forces. During the Station year under review the following leaves have been granted:

Charles Heller, Technician in Biochemistry, January 31, 1943

LeRoy T. Bartholic, Gypsy Moth Scout, January 31, 1943

Bernard L. Poitras, Gypsy Moth Scout, March 15, 1943

Henry J. Bellisario, Gypsy Moth Scout, June 1, 1943

William J. Griesing, Greenhouse Man, July 1, 1943

Resignations and Appointments

Dr. Frances Clark Beard, Cytologist, resigned October 1, 1942. She was succeeded by Miss Jeannette Lowe, B.A., Wellesley, (Oct. 1, 1942).

After 14 years of loyal service, Mrs. Barbara Brezosky Schread resigned on January 16, 1943. In recent years Mrs. Schread handled the purchases. Miss Emily Brough was appointed in her stead on Jan. 11, 1943. Miss Madeline Pepe (Aug. 10, 1942) and Miss Elinor Fitzgerald (Oct. 26, 1942), also, joined the Main Office staff.

Mrs. Viola Farley was transferred from the Main Office to the Department of Entomology to take the place of Miss Betty Scoville, secretary, who resigned on November 21, 1942.

Mrs. Mildred Preston (June 30, 1943) and Mrs. Jane Andrew Wood (Sept. 30, 1943) resigned secretarial positions. They were succeeded

by Miss Jeanne E. Emerson (July 1, 1943) and Miss Beverly J. Parker (Oct. 1, 1943).

Mr. Oliver E. Nelson, M.S., Yale, succeeded Louis Roberts as Assistant in Genetics on June 1, 1942.

Dr. C. I. Bliss, who for the past two years has been Consulting Biometrician, was made Station Biometrician on July 1, 1943.

Dr. Douglas E. Greenwood was appointed Assistant Entomologist, May 1, 1943. He is devoting all his time to wireworm investigations.

Mr. George R. Smith was transferred from the Department of Entomology to take the place of Theodore Stickney, Sampling Agent, who resigned July 15, 1943.

Miss Evelyn Smith, B.S., University of Connecticut, was appointed Research Technician in Soils July 1, 1943, to fill the post left by Mr. Edward Rubins, July 1, 1943, and by Miss Margaret MacEwan, December 31, 1942.

Dr. Jane K. Winternitz, Assistant Biochemist, resigned October 15, 1943.

Honors

Dr. H. B. Vickery was elected to membership in the National Academy of Sciences at the spring meeting, 1943.

Progress of the Station's Work

ENTOMOLOGY

Japanese Beetle Still a Major Pest

Since the Japanese beetle was first found in Connecticut in Stamford in 1926, it has spread over much of the State and has become a notorious pest in several towns. The region of heaviest infestation includes roughly the shore towns from Greenwich to Madison and a broad zone from New Haven north through Hartford to the Massachusetts line. There is also a fairly heavy infestation around New London, and the beetle became abundant in 1943 in the Naugatuck Valley up as far as and including Waterbury. In Greenwich the insect is reported to be noticeably less abundant than in previous years.

The adult beetle is a serious pest of many plants, and on some of these its control is still difficult. During the past season we were able to protect grape vines with a single spray of lead arsenate and a sticker applied early in July. This protected the sprayed foliage throughout the season, and although the new growth which developed subsequent to spraying was injured, this did not prevent the development of the fruit. A spray of lead arsenate and bordeaux applied at the same time was not quite so satisfactory, although much better than any other material except the above.

A heavy infestation occurred in several fields of edible soybeans grown for seed in North Haven. The injury was 25 to 50 per cent of the foliage destroyed. Lime-aluminum sulfate sprays and lime dust repelled the beetles, but neither adhered to the foliage satisfactorily and the insects returned to the fields within a few days. Sprays of lead arsenate with safeners and oil injured the foliage. A one per cent rotenone dust protected the plants about one week.

In many localities the beetles were quite injurious to the sweet corn crop, on the silks of which they feed.

We have been distributing the bacteria which cause "milky" disease of the grubs for several years and have studied its effect on the grub population. During 1943, 959 half-acre plots were inoculated, for which about 839 pounds of spore dust were used. Of these plots 33 were in Fairfield County, 354 in New Haven, 173 in Middlesex, 398 in Hartford and one in Tolland. Almost all the heavily infested parts of the State have now been treated. Continued examination of these plots shows not only an increase in the development of the disease in many areas but also a general spread throughout the treated region.

Japanese Long-Horned Weevil

This weevil (*Calomycterus setarius*), of Japanese origin, has been present in certain localities of Connecticut for a number of years and its potentialities as a pest have caused us some concern. The adults feed on a large number of plants, including vegetables, flowers, legumes and field crops, weeds, vines, trees, shrubs and house plants. In 1943, 22 new hosts were added to the already long list.

Our cage experiments show excellent control of the weevil with cryolite dust of as low as 6.25 per cent concentration. A dust containing 25 per cent cryolite was more effective than sprays of either cryolite at 3 and 4 pounds per 100 gallons or lead arsenate at 3 pounds per 100 gallons. Further study is in progress on the spread of the insect and on its control.

Wireworm Investigation Under Way

The control of the eastern field wireworm is a major problem for potato growers in Connecticut. The larvae are seriously injurious to the tubers, and the quality of the crop suffers. Although we have previously studied this pest, particularly in relation to its injury to tobacco, we began an extensive investigation of the insect this year. One member of our staff is devoting his entire time to the problem. Wireworm injury was severe this year in restricted areas in Hartford County and caused the usual loss to the crop. In cooperation with the Department of Agronomy of the Storrs Station the wireworm injury to potatoes grown in rotation with green manures is also being studied.

Insect Pests of Fruits

Investigations aimed at the control of pests of orchard fruits have devoted particular attention to the European red mite, the oriental fruit moth and the apple maggot. The problem of controlling Comstock's mealybug has also been attacked.

Red Mite

Spray tests with new compounds to control the red mite have been carried out in cooperation with the U. S. Rubber Company. Although considerable progress has been made by the company in developing mite control without the use of rotenone, further experiments are needed to establish its usefulness in orchards. The dinitro-cyclohexyl-phenol compound, marketed as DN 111, applied as a spray in apple orchards has given effective red mite control but care must be exercised in using it in order to avoid injury to the foliage. A schedule with fewer applications but including white mineral oil sprays, ending June 9, gave satisfactory mite control, whereas mite populations increased and did considerable damage in plots receiving lead arsenate and flotation sulfur in a five-spray schedule ending July 10.

Oriental Fruit Moth

The distribution of parasites of the oriental fruit moth has been continued. Although no fruit set in most Connecticut peach orchards this year, 59 growers ordered *Macrocentrus ancylivorus*, and 144 colonies containing approximately 37,000 individuals were distributed.

In laboratory experiments it has been found that the hibernating larvae of the fruit moth will withstand zero degrees Fahrenheit, if the temperature is lowered gradually. There has been no survival below that temperature.

Apple Maggot

Attempts to control the apple maggot, and some other orchard pests, with sprays containing cryolite failed this year, probably because of poor adhesion of the material to fruit and foliage. Experiments with stickers, using lead arsenate as a toxicant, showed that three heavy applications in May and June gave better protection against maggot than five applications of sulfur-lead arsenate which included one maggot spray about July 10. Preliminary cage tests with a new insecticide which contains neither arsenic nor rotenone were very promising, and this material may prove valuable in maggot control.

FIGURE 2. Japanese beetles feeding on corn silks.

Adult flies of the apple maggot.

Comstock's Mealybug

The infestation of Comstock's mealybug in orchards has declined, but we have started breeding parasites of this pest. During the summer Dr. Clancy of the U. S. Bureau of Entomology and Plant Quarantine sent us two shipments (1,250 individuals) of mealybugs parasitized by *Pseudaphycus* and 11,600 adult parasites of the same species. These were released in three apple orchards where mealybugs appeared to be most abundant.

Survey of Insects of Connecticut

In connection with a continuously operating survey of the insects of Connecticut another bulletin of the Connecticut Geological and Natural History Survey, The Diptera or True Flies of Connecticut,

was published this fall. This was written by three well known entomologists and is the first of a projected series of bulletins on the flies of this State.

Inspections and Quarantines

Because of the federal Japanese beetle and gypsy moth quarantines a large amount of plant and other material must be inspected before shipment to uninfested parts of the country. In the past year, 3,237,011 plants were inspected for Japanese beetles, and 4,415 gypsy moth certificates were issued.

Many states quarantine certain plant materials because of the European corn borer. As this insect spreads westward, the amount of plant inspection necessary decreases. In 1943 we issued 420 certificates.

A total of 326 seed inspection certificates were issued for seeds consigned by Connecticut seedsmen to foreign countries, and 310 package certificates were issued for shipments of miscellaneous plant materials.

Nursery and Apiary Inspection

An increased production of honey and beeswax is much to be desired at this time, but the severe weather of the winter of 1942-43 killed about 30 per cent of the bees, so the quantity of honey produced in 1943 was less than in 1942. The quality was a little better. The apiary inspectors examined all known colonies of bees in the State. American foul brood was found to be more serious in Fairfield County than elsewhere.

The number of nurseries in the State declined somewhat during the past year, but 317, involving 4,596 acres, were inspected during the season. The usual number of insect pests and diseases were found.

Gypsy Moth Control

The gypsy moth infestation was generally low throughout the infested part of the State in 1943, due in part at least to the heavy mortality of eggs caused by the low temperatures of last winter. This was fortunate because our staff is greatly reduced by the war. A summer survey of all towns east of the Connecticut River revealed no serious outbreaks.

The Station crews did no spraying, but the federal men sprayed about 41 acres of woodland and 50 trees growing in the open in western Connecticut. The state and federal crews carried on the usual scouting operations. The Bureau of Entomology and Plant Quarantine carries out extensive control operations in western Connecticut to prevent the westward spread of the gypsy moth. The fine cooperation of Mr. R. A. Sheals, in charge of the federal work, and Messrs. Crossman and Blaisdell of his staff is appreciated.

Pine Shoot Moth and White Pine Weevil

These investigations are primarily studies of the effect of insect populations on the development of pine plantations. In the red pine stand in North Guilford the shoot moth population had reached a density that was effecting marked injury to the trees. Low temperatures during the winter of 1942-43 have eliminated the insect, and the pines are now free of infestation. The trees have reached a height where the stand may close before an injurious shoot moth population can build up, and hence the stand may not suffer further from the attack of the insect.

We have finished 10 years of observations of the effect of the white pine weevil on plantations at Rainbow and are analyzing the data.

Shade Tree Pests

The biology and control of the dogwood borer, a serious pest of ornamental and native flowering dogwoods, are under investigation. The insect presumably successfully attacks only injured trees, and a knowledge of the conditions conducive to attack and of methods of controlling its injuriousness may have a broad application.

In relation to the general problem of the effect of insect injury to the health of shade trees, the effect of defoliation on elms is being studied.

Several Ways of "Stretching" Sprays

Good control of plant pests involves the application of materials where and when they are most needed, and in the right quantities. Briefly, this means good coverage of plants and, incidentally, the efficient use of chemicals. Station entomologists and plant pathologists are cooperating on a series of experiments involving techniques of applying sprays and dusts. The progress to date is briefly summed up in the following paragraphs.

Previous work has demonstrated that the toxicity of certain dusts (rotenone in ground derris root) is markedly affected by the type of material used as a diluent, usually termed the "inert" carrier. Further field experiments have shown similar results with other toxic materials. A concentrated nicotine bentonite was mixed with clay and with pyrophyllite and tested on the European corn borer. Approximately 5 per cent nicotine was required in the clay mixture to equal the effectiveness of 3 per cent in the pyrophyllite mixture. When mixed with cryolite and tested on the Mexican bean beetle, the pyrophyllite proved only slightly superior to clay. Free nicotine dust prepared from a powdered concentrate was much more effective with pyrophyllite as a diluent than with hydrated lime. In terms of nicotine required, one per cent nicotine in the pyrophyllite mixture was as effective as 10 per cent in the hydrated lime when used against cabbage aphids.

During the last two years experiments designed to furnish information on the relation of concentration of toxicant and method of

application to degree of control of pests, have provided a measure of the degree of coverage attained by different methods of application. Beans and cabbages were dusted with mixtures containing rotenone and cryolite respectively. Increasing the number of nozzles on the duster from one to two per row appeared to improve the coverage more than did use of a larger feed slot or operating at a slower ground speed.

In all cases dusts of higher toxicant concentration applied in smaller quantities were more effective than those of lower concentration in larger quantities. Thus 20 pounds of a one per cent rotenone dust per acre gave better results than 40 pounds of one-half per cent dust.

In studying the effect of combining other insecticides with rotenone dusts it was found that a thiocyanate, marketed as Lethane 60, tested on aphids, when used to replace up to 75 per cent of the rotenone content of the dust, resulted in a more efficient use of the rotenone. Results in the same direction, but less marked, were obtained in tests on the Mexican bean beetle.

Rotenone dusts were compared with cryolite in controlling the potato flea beetle, the European corn borer on potatoes, the Mexican bean beetle, and cabbage worms. A dust containing 25 per cent cryolite was as effective against the flea beetle as one containing one-half per cent rotenone, and 33 per cent cryolite was as effective against the European corn borer on potatoes as one per cent rotenone. Against the Mexican bean beetle 50 per cent cryolite was as effective as one-half per cent rotenone, and against cabbage worms 25 per cent cryolite was more effective than one-half per cent rotenone. There appeared to be no difference in toxicity between natural and synthetic cryolite.

Cryolite is an excellent insecticide that has been used for a number of years to control many insect pests, and in many cases it can be used in place of rotenone with satisfactory results.

As a result of laboratory and field experiments we have obtained information about the value of certain adhesives and safeners in holding in check common insect pests and diseases of orchard fruits with fewer spray applications than commonly used. This year such a reduced schedule on apples gave better scab control, better mite control, less fruit russet, and better foliage at the end of the season. However, the control of curculio and redbug was less effective.

PLANT PATHOLOGY AND BOTANY

Dutch Elm Disease in Connecticut

The federal authorities made a determined fight to wipe out the Dutch elm disease in the United States. Despite their best efforts, Nature won the battle and it now appears that we must learn to live with the Dutch elm disease. The question immediately arises as to what can be done locally toward its control. The Station is doing active research on several phases of the problem, and is cooperating with the U. S. Department of Agriculture on certain control operations.

In the southwestern part of the State the infection of elms is increasing, probably as a result of the cessation of extensive control work by the federal Bureau of Entomology and Plant Quarantine three years ago. This Bureau is at present confining its activities in Connecticut to an effort to prevent the spread of the disease into the eastern half of the State. In the generally infected area in western Connecticut we look upon the actual control of the disease as a local problem and are urging the town authorities and the private citizens to get rid of diseased trees before bark beetles emerge from them, and to keep valuable elms in a healthy condition.

FIGURE 3. Advanced case of Dutch elm disease.

Scientists are now generally agreed that valuable elms in villages and cities can probably be protected by maintaining a zone of disease-free elms around each locality. This can be done by prompt detection and removal of any trees that may contract the disease. Recent research here gives some evidence on the necessary width of this zone.

It shows that the probability of infection falls rapidly with distance. For example, the probability of infection at 500 feet is one in 500, but this probability falls rapidly to one in 10,000 at 1,000 feet.

The elm bark beetle mainly responsible for transmitting the disease to healthy elms has been found quite resistant to low temperatures during the winter, when it is in the larval stage, but the severe cold of the last winter apparently caused a heavy mortality. This bark beetle was less abundant in the State in 1943 than for many years previously.

New Fungicides Show Promise

For some years the Station has been engaged in research on new and improved fungicides for plant disease control. One just announced has a property that has been sought for many years. It is water-soluble so that it gives a film-like cover over a sprayed leaf. On drying, the material is invisible and water-insoluble, hence resistant to removal by rain. It also has some properties of insect repellancy. Known chemically as disodium ethylene bisdithiocarbamate, the new fungicide as yet has no trade name.

The material seems to be promising for use on ornamentals because the residue is wholly invisible. For the same reason it should be useful for harvest applications on such things as tomatoes, peaches and cherries. Onions and other vegetables that are difficult to wet might take this material better than other fungicides.

Another fungicide recently developed here is juglone. This is the substance that is excreted by walnut roots and is known to kill taprooted plants like alfalfa and tomatoes. Laboratory tests with the synthesized form of juglone prove that this material is more toxic than copper oxide, commonly used as a fungicide before the outbreak of the war. Further study will be made on the toxicity of juglone and other substances produced during its synthesis.

Poison Ivy Control

Because it is so very common, poison ivy is sometimes jokingly called the state flower of Connecticut. And ivy poisoning might well be called the state disease of Connecticut in the summer time. As a result there is much interest in the eradication of this pestiferous plant. Several of the common weed killers have gone to war but it now appears that a promising substitute may be had in borax, at 10 pounds per square rod.

Causes of Root Rot Diseases

One of the reasons for the decline of onion production in Connecticut is that pink root and smut diseases have so infested the many soils as to make onion production unprofitable. Several other economic crops, such as strawberries, tobacco, peas, cabbage and potatoes, suffer from diseases of the below-ground parts. These troubles are exceedingly difficult to get at and, except in isolated cases, it has been

difficult if not impossible to control them by treating the soil. Potato scab and club root of cabbage are outstanding exceptions.

The answer to most of the root troubles has been to stop growing the crops. But if land is first taken out of production because of strawberry black root, and then because of pea root rot, and then because of onion pink root and, finally, if cabbage and potatoes cannot be grown on the same land, the farmer finds himself limited in the possibilities of earning a living.

We have embarked on the investigation of root rot as an interrelated, although complex, field rather than as a collection of isolated maladies. One of the new developments is that decomposition, especially the decomposition of the preceding crop residue, may be related to root rot development. It is well known that timothy sod encourages tobacco brown root, for instance. Another potent possibility may be that root rot in many cases is really a mineral deficiency rather than a result of the action of pathogenic microbes. These factors are currently under investigation.

Shading Reduces Defoliation of Tomatoes

Fifty years ago Dr. B. D. Halsted in New Jersey wrote that shaded tomatoes on the farm at Rutgers University did not lose their leaves as much as those grown in the open sun. This fact was confirmed experimentally here in Connecticut last year. It offers promise especially to victory gardeners as a means of reducing the effects of this disease. Shading also markedly reduces the cracking of tomato fruits.

Injury to Potatoes From Bordeaux Mixture

For 60 years bordeaux mixture has been a standard treatment in the control of plant diseases. Except in rare cases, it has no peer so far as efficiency in disease control is concerned. But it does produce considerable injury in some crops. For this reason it began to lose its preeminence on fruit as early as 1906-08 when sulphur materials were introduced. And in the early nineteen-thirties, when the fixed coppers were introduced, its use on vegetables began to wane.

Bordeaux mixture has retained its popularity for use on potatoes chiefly because bordeaux-sprayed potatoes usually outyield those not sprayed. Where, therefore, lies any injury to this crop? Sprayed potatoes do not look injured; in fact, they look superior to unsprayed potatoes.

The answer is that the injury is masked by the pest control. Earlier, we thought that flea beetles, for example, probably reduced the yield of Cobblers by only 10 or 15 per cent because bordeaux mixture controlled the pest and increased the yield by approximately that figure. By proper experimental designs it has been possible to demonstrate that flea beetles reduce the yield by about 40 per cent, while bordeaux mixture reduces the yield by about 25 per cent. The difference of 15 per cent justifies spraying the potatoes.

Search will be continued for a material which will equal bordeaux mixture in the control of pests but which, at the same time, will not reduce yield. In the meantime, injury to potatoes by bordeaux mixture can be reduced somewhat by lowering the proportion of lime in the mixture to half that of the copper sulphate. It is additionally helpful to use dolomitic lime rather than hydrated lime.

Another way to avoid bordeaux injury is to use the material only when necessary. In Connecticut, potatoes seldom need protection before July 1. Cobblers planted early for the early crop need not be sprayed at all with bordeaux mixture. The attack of flea beetles on the crop in June can be controlled with dust of barium fluosilicate or cryolite rather than with bordeaux.

GENETICS (Plant Breeding)

Sweet Corn for a Month From One Planting

A succession of sweet corn varieties can now be planted at one time and sweet corn picked over a period of a month. The most popular succession is: Spancross, Marcross, Carmelcross, Lincoln, Golden Cross Bantam and Wilson. These varieties will mature in the order listed. If they are planted about May 15 to 30, and a repeat planting of Golden Cross Bantam and Wilson is made three weeks later, one may have sweet corn maturing from July until September. This type of succession is particularly valuable for growers who want to market sweet corn continuously, and it appeals to many home gardeners. Breeding work now in progress is expected to provide an even better succession. Another variety is needed between Carmelcross and Lincoln to bridge the six-day interval between these varieties.

Special emphasis is being given to improving the quality of sweet corn. In the past, this has received little attention. New hybrids of superior quality are being substituted for the originals. The production of inbred lines of similar maturity is a very important phase of the work. Such inbreds are easier to handle for seed production and should reduce the cost of production of hybrid seed.

Selection of Corn for Grain and Ensilage

The selection of a satisfactory variety of corn for grain or ensilage must take into consideration adaptation to local conditions and proper maturity. These differ with the soil, fertilization, length of growing season and time of planting, as well as seasonal conditions. An observation field of 200 new hybrids was grown on the Station farm last summer to survey the available material in a preliminary way. Replicated yield tests of the commercial and experimental hybrids most promising for Connecticut were also made. A recommended list of varieties, which is revised and brought up to date each year, is available to growers.

Farmers' trials were made in different parts of the State. A number of these were made in cooperation with the New Haven County Farm Bureau, the corn being grown by 4-H Club boys. Record high yields, well over 100 bushels per acre, were obtained from many of these trials.

A selected group of 55 yellow dent inbreds were grown in 1943 and crossed in all combinations for further testing. Measurements were taken for yield, moisture in the ears at harvest, stalk breakage and erectness of stalks. From these results the most promising double crosses can be predicted.

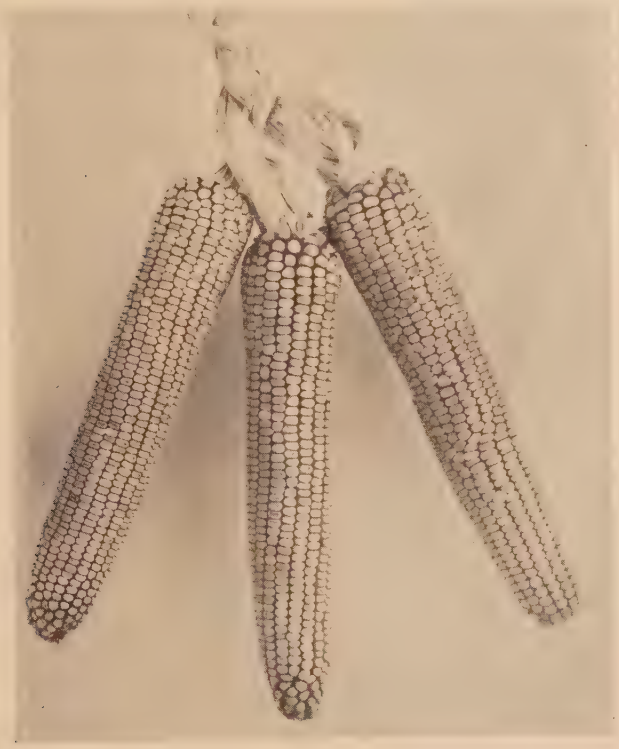

FIGURE 4. Experimental hybrid yielded 99.8 bushels per acre at Guilford, Conn., in 1943.

Corn and Genetic Principles

For several years all of the long-inbred strains of corn have been examined carefully for changes that may persist. So far, none has been found that improves the plants permanently in their ability to grow and reproduce. A number of small changes have been found that reduce the plants in various ways. These appear to be degenerative changes, all of which either delay development or lower reproductive ability.

When these degenerate lines were crossed back with the original line from which they came, a surprising hybrid vigor effect was noted in several cases. It is thought these reduced lines may have importance in the study of the phenomenon of hybrid vigor.

A study of variation was made in sweet corn inbred lines under continuous self pollination. Considerable variation was found in Purdue 39 (P39), the most widely used sweet corn inbred and parent of Carmelcross and Golden Cross Bantam. Connecticut 30 (C30), a sub-strain, is in every respect very similar to P39 except that it is much smaller. Tests made in 1943 showed an increase in yield of 25 per cent of the P39 x C30 cross over that of the P39 inbred. If such an increase persists in future tests, it will have practical applications of considerable value to commercial seed producers.

A further study of spontaneous chromosome aberrations in the endosperm of the corn kernel has shown growth changes accompanying breaks and realignments in the *bt* and *pr* region of chromosome 5. In this study a total of 14,505 seeds were examined under a low power microscope. Nineteen cases of spontaneous growth changes were found associated with the loss of known gene markers. They illustrate the control that nuclear substances have upon growth processes.

Strawberry Breeding Project Completed

Several named varieties – Shelton, Hebron, Bristol and Branford – have been turned over to nurseries and are being grown in the Northeast. It will take some time to determine their usefulness. This completes the strawberry breeding project begun in 1923. A recommended list of strawberry varieties that have been tested under Connecticut conditions will be sent to all interested. This gives the time of ripening and yields over a six-year period for the varieties that have the most promise for market and home gardening.

New Connecticut Vegetable Varieties

Squash

The present objective of the summer squash breeding is to develop inbred lines that can be used to produce better first-generation hybrids. Yankee Hybrid, released some time ago, has some undesirable features, despite its superior production of early fruit. Our inbreds that give the best combinations for earliness and high production have an undesirable dominant two-toned or striped color character. Many crosses have been made and some inbred lines have been selected which do not have this character. These lines will be hybridized with Early Prolific Straightneck and other inbred lines to determine their usefulness in the production of first-generation hybrids.

Many inbred lines of squash were lost in 1942 and 1943 when our plantings were attacked by the foot rot disease. As yet no lines have been found that are resistant to this disease.

Cucumbers

Downy mildew is the most serious limiting factor of production of cucumbers in southern New England. Two lines of cucumbers have been found that are resistant to this disease but they lack quality and productivity. These have been hybridized with other varieties, and selections are being made for high quality, productivity and mildew resistance.

Tomatoes

In 1943 one of our new tomatoes, known as Connecticut No. 3, was distributed to a limited number of growers. Reports from these trials have been enthusiastic concerning its uniformity, size, color and productivity. Connecticut No. 3 results from the hybridization of several varieties followed by five generations of selection. It has a slightly larger than standard vine growth. The fruit ranges in size from 4 to 8 ounces, is spherical, smooth, has few cracks and a small core. It ripens uniformly to a deep red color. The ripe fruit has another good quality- it is easily peeled. It has been acclaimed by all who tried it as an ideal home garden tomato for canning, juice and salads. Connecticut No. 3 gave yields of early and total fruits comparable to those of Pritchard, Rutgers and Stokesdale. One victory gardener reported a yield of 897 marketable fruits of good size from five plants. This number of fruits would be equivalent to 5 bushels.

More extensive trials will be conducted in 1944 to determine the adaptability of Connecticut No. 3 to commercial production.

Peppers

A new pepper, that has been named Charter Oak, would seem to attain the goal set in our breeding program. Charter Oak is an early thick-fleshed, dark green pepper of the California Wonder type. In production and quality it is outstanding. Several lines will be available for testing by growers in 1944.

A new series of hybrids has been started to incorporate mosaic resistance in Charter Oak. Second-generation resistant lines have already been selected and these will be back-crossed to Charter Oak.

SOILS

Fertility Losses in Sandy Soils

The Connecticut River Valley is planted extensively to tobacco, potatoes and vegetables. Valuable as it is in many respects, this sandy soil presents one serious problem, that of loss of fertilizers by leaching. This is particularly true of nitrogen. Hence growers must practice methods of fertilization that provide adequate nutrients for crops but at the same time avoid fertilizer losses through soil drainage.

Experiments were conducted from 1931-41 at Windsor, in the Connecticut Valley, in an effort to solve the leaching problem. Results

of one of the experiments, known as Windsor lysimeter series C, have been published in Station Bulletin **466**. Briefly, the more essential findings are these.

(1) Cover crops, of which rye was most effective, greatly reduced losses of nitrogen by leaching. There was very little loss under grass sod, even where fertilization was liberal. (2) Soil organic matter losses averaged 15 to 18 per cent on fallow soils, but were much less on cropped soils. Cover cropping resulted in some gain. Under grass sod where no nitrogen was applied, organic matter decreased; but with fertilzer there was a gain.

(3) Cover crops had but little effect on tobacco yields but they tended to favor nitrogen utilization by the crop. (4) Comparison of leaching losses and crop removals with the amounts of nutrients added showed a net gain over the 10-year period for all constituents except nitrogen and calcium.

(5) Nitrogen fertilization favored depletion of soil bases. Cover crops tended to stabilize the soil against losses.

Boron and Magnesium

That crops show marked differences in their requirements for certain elements was illustrated when radishes and celery were grown on a soil originally deficient in boron, magnesium and phosphorus. Radishes were not sensitive to boron deficiency but yields were increased by the application of magnesium and phosphorus separately or together. The application of boron (as borax) increased celery yields some 60 per cent and decreased susceptibility to blight. This crop was sensitive to magnesium deficiency, to high acidity, and especially to acidity and phosphorus deficiency together.

Soil Testing a Regular Service

During the 12 months ending October 31, 1943, a total of 3,600 soil samples were received and tested at New Haven and Windsor, the number being about equally divided between the two laboratories. The proportion of farm samples to home or victory garden samples varied widely, however. On a percentage basis the comparative figures are as follows:

	New Haven	Windsor
Farm soils	18.6 per cent	87.5 per cent
Market garden soils	2.9	9.0
Home garden soils	51.5	1.9
Miscellaneous	27.0	1.6

Digested Sludge as a Substitute for Manure

Digested sludge from sewage disposal plants contains 35 to 50 per cent organic matter. It compares favorably with manure in nitrogen and phosphorus content but is very low in potash. Greenhouse experiments are being conducted to determine its value when applied to the soil, always in conjunction with a complete fertilizer.

Tests were made during the spring and summer of 1943 on tobacco and snap beans. Sludge was used at the rate of 10, 20 and 40 tons per acre, plus a 3-8-7 fertilizer at 1,200 pounds. The first crops were planted immediately and gave a small increase for the 10 and 20-ton rates, but not the 40. The second crop on the same soil without further sludge additions showed gains of 50 to 90 per cent over the no-sludge soil.

The inference is that sludge is a good material, but acts slowly, and that too much may be applied immediately before planting. Continued use of sludge would require a 5–10–10 or similar high potash mixed fertilizer as supplementary treatment. To obtain satisfactory yields for the first crop immediately following the application of sludge, additional nitrogen would be necessary.

Earthworm Castings Are Rich in Plant Nutrients

That earthworms are beneficial to the soil is a fact well established many years ago. The specific ways in which they are beneficial, however, are still a subject for study. During the past year the physical and chemical properties of castings in a cultivated field and in four forested areas were compared with those of the surrounding soil mass. There was no difference in clay or in total colloid content, but in all cases the castings were markedly higher in nitrate nitrogen, total nitrogen, total calcium, and available or exchangeable phosphorus, potassium, calcium and magnesium, organic matter, base capacity, base saturation, and moisture equivalent.

The total weight of castings in the cultivated field at the time of sampling was estimated at 16,300 pounds per acre, or a little less than 1 per cent of the total soil mass to the plow depth. This field is probably above the average in earthworm population. Inasmuch as the production of castings is a continual process, a considerably larger portion of the total soil mass is affected than is indicated by the figures.

Plant Tissue Testing

In some cases, crops do not grow as well as our standard soil tests predict. Obviously when other factors such as water, temperature and light are unfavorable, growth will be restricted irrespective of the plant food supply. What is the effect of variations in these factors on the composition of the plant?

In a greenhouse experiment with corn and potatoes some plants received only a minimum amount of water, some were kept under cool, partially shaded conditions with an abundance of water and others were grown under normal conditions of light, heat, and moisture. Concentrations of nitrates, phosphorus, potassium, calcium, and magnesium were determined in the plant tissues, and correlated with growth.

The yield of corn stover was lowest under cool, partially shaded conditions with abundant moisture; intermediate where light and heat were ample but where moisture was deficient; and highest under

normal conditions of light, heat and moisture. The concentration of nitrates and potassium in the leaves varied inversely as the yield, while phosphorus varied more or less directly with the yield.

In the case of potatoes, yield of tops was lowest under "dry" conditions and highest under "normal", but the tuber yield was highest in the "cool" pots. Analysis of the basal portion of the stems showed that the concentration of nitrates, potassium and phosphorus varied inversely with the size of the tops.

FIGURE 5. Effect of environment on growth.

In the hybrid poplar experiment described below, plant tissue tests of the leaf petioles showed that a high content of available phosphorus and exchangeable potassium in the soil is reflected in the composition of the petioles irrespective of the growth response of the plant.

Results to date indicate that with fertile soil, an unfavorable growing season results in fair growth and medium to high concentration of nutrients in the plant. Low tissue tests indicate a deficiency in plant food supply and even though growth may be fairly good, a higher level of soil fertility would result in greater yields, provided other conditions were favorable.

Hybrid Poplars Need Nitrogen, Phosphorus and Lime

The new hybrid poplars of the U. S. Forest Service have possibilities for pulp wood production. They grow very rapidly and, unlike most forest trees, respond readily to differences in soil fertility levels. A series of soils in "frames" about to be discarded offered an opportunity to measure these responses.

The soils were acid and low in fertility. Additions of nitrogen increased growth 250 per cent, phosphorus 30 per cent and potassium none. In combination with nitrogen or nitrogen and lime, phosphorus added as much as 50 per cent to the nitrogen effect. Lime increased growth, whether added alone, or in combination.

These results are in striking contrast to those obtained in previous years on conifers and maples.

FORESTRY

Forest Composition in Relation to Soil-Site Conditions

In a small state like Connecticut with its relatively uniform soil and climatic conditions, soil type is not necessarily the controlling factor in forest composition except where it is based on differences in moisture and depth. Other factors of site, such as degree and direction of slope, moisture supply and specific qualities of the soil profile, also enter into the picture.

Last summer the Soils Department conducted a survey on three tracts in Meshomasic and one in Cockaponset State Forests to learn what factors of site were related to distribution and size of trees of the several species. Total basal area, i.e., the sum of the cross-sectional areas of the trunks of each species, was used as a basis for comparison.

Fifteen species comprised 88 per cent of the timber. These were, in descending order, red oak, black birch, red maple, white oak, yellow birch, chestnut oak, black oak, scarlet oak, white ash, tulip, gray birch, pignut hickory, aspen, sugar maple and blue beech.

On the drier soils chestnut and black oak had significantly higher basal areas; on moist to wet sites, red maple, yellow birch, aspen and blue beech excelled. Comparing shallow with deep soils, black birch, red maple, white oak, black oak, scarlet oak, tulip, gray birch and pignut hickory had significantly higher basal areas on the deeper soils. White oak was the only species with greater basal area on steep north slopes. South slopes were too infrequent on these tracts to warrant a separate classification. The effect of three other important factors of site—soil texture, permeability of the subsoil and degree of stocking—were not measured because of their uniformity in the areas surveyed.

Forest Trees Distributed for Thirty-Five Years

Thirty-five years ago the Station undertook to interest Connecticut land owners in reforestation of idle land and to assist them in securing forest planting stock at reasonable cost. This was a form of service which no other agency was in a position to render at that time. In recent years other agencies have more or less duplicated Station activities in this field, so the Station is discontinuing the service. The following is a brief resume of the work and its accomplishments.

Since 1906, the Station has shipped over 19,000,000 trees, mostly conifers. The acreage planted is not definitely known but, on the basis of 1,000 trees per acre, may be estimated as 19,000 acres. Taking into account failures due to fire, insects and diseases, changes in use of land, storms and neglect, 10,000 acres would be a fair estimate of the successful plantations. In addition, there have been many plantations established with stock from other sources for which the Station may claim indirect credit. These include several large plantings by municipal water companies and water departments, as well as those for which stock was furnished by commercial nurseries and the Agricultural Conservation Program. Probably 15,000 acres of planted forest throughout the State is a fair estimate.

FIGURE 6. Fifty-year-old stand of white pine after thinning.

All orders for the Station's remaining planting stock are now placed through the State Forester's office in Hartford, although deliveries are still made from the Windsor nursery. However, the Station will continue to aid woodlot owners on problems they may have regarding the care and maintenance of plantations, as well as the mobilization and marketing of the products. And it is in this field, rather than in the planting of trees, that the Station is expected to be most helpful in future years.

White Pine Blister Rust

Wood lot owners in sections of the hurricane area have an exceptional opportunity to improve their holdings at no ultimate expense. This observation was made by the blister rust control agents now remapping the "blow down" areas in Killingly. The same conditions

probably hold in other towns in the State. A good white pine reproduction was discovered in forest areas that have been thinned by the hurricane. Most of it had developed from seed in the ground at the time of the storm, or previous to that time. If properly managed, this should result in a mixed stand of oak and white pine growing under the most favorable conditions for quality timber. The partial cover of oaks would minimize danger to the pines from weevil.

In cooperation with the U. S. Department of Agriculture and the several towns, the Station carried on its usual blister rust control work in Canaan, North Canaan, Cornwall and Norfolk. Approximately 90,000 wild currant and gooseberry bushes were destroyed on approximately 18,000 acres of control area, giving protection to 6,000 acres of pine. In addition, seven nurseries growing white pine were rechecked, and 20 wild currants and five cultivated currants were destroyed, giving protection to 1,353,500 white pines grown for reforestation purposes.

New Ways of Utilizing Wood for Heating

Bulletin **463**, describing a wood-burning conversion unit for household furnaces designed in cooperation with the Yale School of Engineering, was ready for distribution in November, 1942. Within six months practically the entire issue of 6,000 copies had been mailed out. Requests were received from nearly every state in the Union and from a number of foreign countries.

Some half-dozen conversion units have been installed and are in operation in Connecticut but there is no means of knowing what further application has been made of the principles described. One of the most encouraging reactions to the bulletin was the very large number of follow-up requests for additional information of various kinds. Many of these indicate that the writers have given a great deal of thought to their fuel problems. If the only result of the experiment is to stimulate a demand on the part of the public for manufactured equipment to burn solid fuel more efficiently, it will have been worth while.

Research on combustion of wood is being continued, special attention being given to improvement of the now available stoves, such as the Charwood. Another promising field is the production of fuel gas from wood. The White Memorial Foundation of Litchfield has made a gift of $250 to the Station in furtherance of these experiments.

A Charcoal Kiln of Non-Metallic Materials

Owing to the increasing demand for charcoal, it was decided to attempt the development of a non-metal charcoal kiln. Work was started in the early fall of 1943, in cooperation with the White Memorial Foundation of Litchfield. The type of kiln built was the same as the portable steel one described in Bulletin **448**, and now impossible to construct because of priorities.

The materials chosen for the kiln are cinder concrete blocks (hollow type). Only stock sizes of the blocks have been used. The cost of

materials is somewhat less than for a metal kiln of the same size. No prefabrication is necessary. The preliminary runs show a good deal of promise.

TOBACCO SUBSTATION AT WINDSOR

A Wilt Disease of Tobacco, New to Connecticut

A disease that causes plants in the field to wilt and finally die, was found for the first time in this State in August 1943. The wilting is caused by a parasitic fungus (*Fusarium oxysporum* var. *nicotianae*) which enters the plant from the soil and grows up through the vascular tubes. Affected plants never recover and seldom are worth harvesting.

First reported from Maryland some 25 years ago, Fusarium wilt has been found since in most of the southern tobacco states, Canada, South Africa and Russia. In most of these regions it is not considered a major disease because the proportion of plants affected is small. In some counties of North Carolina, however, it has caused serious losses, and from Maryland come reports that fields have suffered as high as 60 to 80 per cent in plant mortality.

No method of controlling or avoiding wilt has been found except through the breeding or selection of resistant types. Fortunately, the three types we grow in Connecticut are said to be quite resistant. In the cases observed here only a few plants in any field were affected and the loss was negligible. It does not seem likely that the disease will become destructive here, but it should be watched.

Control of Tobacco Mildew

Experiments on control of mildew by spraying with Fermate were continued with good results. In the seed beds at the Station farm—where all sections of the bed were inoculated with spores—the unsprayed plots had 98 per cent infected plants while the plots sprayed twice a week with Fermate had less than one per cent. Repeated greenhouse experiments during the winter gave almost 100 per cent control. Fermate was used by many growers in the spring of 1943 and most of them reported excellent results—although some said mildew came into the beds at a late stage when the plants were large enough to set out.

Two other chemicals, bismuth subsalicylate and benzyl salicylate, were compared with Fermate. These materials gave good control of mildew, but both caused injury to the tobacco plants. Being more expensive and more trouble to prepare, they offer no advantages over Fermate. Neither seems to give the plants resistance to mildew after the spray is discontinued for a few days; this is also true of Fermate.

Further tests with paradichlorobenzene gave excellent control when the beds were fumigated by distributing the crystals on a strip of cheesecloth stretched longitudinally over the center of the bed.

FIGURE 7. Control of tobacco mildew in seed bed. Right, sprayed with "Fermate". Left, untreated.

Methods of Applying Tobacco Fertilizers

In Connecticut the time-honored and standard method of fertilizing tobacco is to broadcast and harrow in the fertilizer on the plowed and levelled field, a week or two before setting the plants. Results of recent experiments at Windsor indicate that some changes in time, place and depth of application might be advantageous.

Time: Four years' records on 24 test plots showed an increase of 7.5 per cent in yield and 5 per cent in grading when the fertilizer was applied the same day the plants were set, instead of 10 days earlier.

Place: Four years' records on 48 plots showed an increase of 3 per cent yield and 13 per cent in grading when the fertilizer was applied in narrow bands on either side of the row instead of distributed uniformly in the soil by broadcasting.

Depth: One years' results on 12 plots showed an increase of 5 per cent in yield, but a reduction of 4.3 per cent in grading when the fertilizer was spread on the land, and plowed under. Although the computed acre value of the crop was about the same, the "plow under" method gave a more uniform stand of plants and less restocking was necessary.

Shade Tobacco Breeding

This project, conducted for four years in cooperation with the Genetics Department and with the Shade Tobacco Growers Association, is yielding promising results. The object is to develop a higher yielding strain that will produce a greater percentage of the best grades of wrapper.

The early years of the experiment were devoted to extensive breeding and selection work, with the elimination of all but the most promising types. Attention is now narrowed down to two or three strains which appear to be quite superior to the ordinary Shade type. They develop more leaves to the plant and make a higher yield per acre. The leaves have a better shape, and grade out better than ordinary Shade, especially in the upper primings.

For testing on a somewhat larger scale and under a variety of conditions, a small amount of seed of the best strain will be supplied to Shade growers who wish to make a limited trial in 1944.

Relative Efficiency of Nitrogen in Oil Meals

Cottonseed meal has been used as a source of nitrogen in tobacco fertilization for at least two generations in the Connecticut Valley. Castor pomace is another nitrogen carrier and in more recent years soybean oil meal has come into use.

Castor pomace is usually second choice to cottonseed meal. Growers have observed that it frequently produces too great a percentage of "darks" and that it delays maturity of the crop. Soybean oil meal is a newcomer, having been introduced about a decade ago. This has received the same criticism as castor pomace, though to a lesser extent.

In an attempt to explain the behavior of tobacco fertilized with different oil meals, experiments have been carried on at Windsor using the three meals as single sources of nitrogen in the fertilizer. In four tests, crop yields and quality produced by 200 pounds of nitrogen in cottonseed meal were equal to those produced by 160 pounds of nitrogen in the form of castor pomace, or by 180 pounds from soybean oil meal.

The explanation for this is that a greater part of the nitrogen in castor and soybean meals becomes active at the critical growth period, than of that in cottonseed meal. This is confirmed by the nitrate levels found in the soil. In previous experiments, when 200 pounds of total nitrogen were applied, the nitrate nitrogen levels were as follows: for cottonseed meal, 26 pounds per acre; for castor pomace, 42 pounds; and for soybean meal, 35 pounds. In the recent trials the same relationship was found.

Thus it would appear that castor pomace and soybean meal will produce tobacco equal to that grown with cottonseed meal, if properly used. In these experiments castor pomace, pound for pound, was found equivalent to cottonseed meal, in spite of the fact that

castor pomace contains only 4.5 to 5 per cent of nitrogen and cottonseed meal 6.5 to 7 per cent. Soybean meal analyses 7 per cent of nitrogen or better, slightly higher than cottonseed. Because of this and its somewhat higher activity, 1,700 pounds of soybean meal gave results equal to a ton of cottonseed meal.

ANALYTICAL CHEMISTRY

Fertilizer Grades Reduced in Number

Tonnage returns indicate that about 73,000 tons of fertilizer were used in the State, as compared with 65,000 tons in 1942. Both figures are exclusive of fertilizer distributed in connection with the federal Agricultural Adjustment Program. Nearly 6,000 tons of 3-8-7, the grade especially designated for victory gardens, was sold in Connecticut. The inspection for the current year shows that guaranties were well maintained and regulations complied with.

By order of the Food Production Administration, the number of grades of fertilizer was greatly reduced. Instead of the normal 60 to 65 grades, only 15 were permitted. The purpose of the order was to effect a more economical use of fertilizer chemicals available for crop production and to conserve chemical nitrogen vitally needed for the manufacture of munitions. Within the limits imposed by shortages of materials, the grades permitted were adapted to Connecticut crops and conditions.

Commercial Feeding Stuffs

Based on the livestock and poultry population it has been estimated that the annual grain consumption in the State is about 460,000 tons, of which 210,000 is for dairy herds, beef cattle and other livestock, and 250,000 for poultry.

Feed grain shortages and the uncertain supply of ingredients for mixed feeds have created a difficult problem for feed manufacturers. It has been impossible for them to maintain fixed formulas, and frequent revisions have been necessary. So far as this situation was reflected in the 1942 inspection year, guaranties were well sustained. About 1,000 samples, including vitamin D carriers, were examined and over 95 per cent of guaranties made were substantially met or exceeded. The grain shortage has been more acute in the current year, 1943, for which inspection data are not yet available.

Sixty-one biological specimens were examined in connection with cases of suspected poisoning of livestock and poultry. In about one-third of these, poisonous substances were found that suggested probable causes of mortality. Arsenic, lead, cyanide, strychnine and yellow phosphorus were the poisons found. Commercial feeds were not involved in any of these cases; mortality was the result of failure to prevent animals from gaining access to insecticides or other poisons used on the farm, or in some cases probably due to malicious distribution of poisoned bait.

Food and Drug Products Tested

Of over 1,800 samples of foods, drugs and cosmetics examined in the past year, olive oil showed the greatest percentage of adulteration and misbranding. Fifty-one of 64 official samples submitted by the Dairy and Food Commissioner were illegal, mainly because they were sold as olive oil but contained substitutes of common vegetable oils, such as corn, cottonseed and peanut oils. Coffee was not found to be adulterated notwithstanding the imminence of rationing at the time the survey was made. Mixtures of coffee with chicory, or other non-coffee material, were properly labelled. Ninety per cent of the samples of vitamin D milk examined fully or substantially met the unitages of vitamin D claimed for them.

The appearance of horse meat on the market in some sections of the State raised the question of its detection in comminuted meat products such as hamburg steak and frankfurt sausage. A chemical method which distinguishes horse fat from the fats of beef, mutton and pork has diagnostic possibilities. So far as it has been applied to market samples suspected of containing horse meat, no evidence was found to justify the suspicion.

BIOCHEMISTRY

Metabolism of Asparagine

Research on asparagine has been continued with the object of demonstrating that asparagine can be economically prepared from the seedlings of species of lupines available from an American grown crop. A blue lupine, *Lupinus angustifolius*, now being produced in substantial quantities in Florida has been shown to provide a suitable source. After being sprouted in darkness for 12 days, the seedling tissue yields a quantity of pure asparagine the equivalent of about 9 per cent of the weight of dry seed taken. This species thus compares favorably with the imported *L. albus* which, although it yields a somewhat higher proportion, requires a longer culture period to do so.

The unexpected observation was made that the asparagine in *L. angustifolius* seedlings reaches a maximum concentration at about 12 days and then rapidly decreases, the nitrogen previously combined in the form of asparagine being liberated in the form of ammonia. The possibility that this was due to invasion of the tissues by micro-organisms was ruled out by examinations kindly carried out by the Botanical Department, and the inference drawn that synthesis of asparagine in this species depends upon the supply not only of ammonia derived from protein decomposition but also on a supply of some other component or metabolite. At a certain stage of development, namely that reached in about 12 days of culture, the supply of this component becomes exhausted. Asparagine synthesis therefore ceases and the mechanisms which provide for asparagine decomposition assume dominance. The effect is an apparent reversal of the general course of the metabolism.

This observation was confirmed upon seeds of American origin from both 1942 and 1943 crops. It is a type of behavior not previously recorded for lupine species in general, nor for seeds of this species studied in Europe and in Australia. The phenomenon provides an opportunity for more detailed study of the mechanism of amide synthesis.

The asparagine metabolism of a typical species of vetch, *Vicia atropurpurea*, has also been investigated. The seeds of this plant were found to be less satisfactory for asparagine production than the lupines.

Sources of Glutamine

Inasmuch as glutamine, the next higher homologue of asparagine, has in recent years assumed considerable importance as an essential component of certain culture media used in bacteriological investigations, the search for possible sources of this extremely rare substance has been renewed. Convenient methods to prepare it from beet root tissue were developed here about eight years ago but, since beet plants in which the glutamine content has been increased by treatment with ammonium salts are available only seasonally, it seemed desirable to study the possible use of seedlings for preparation purposes. Such tissues could be prepared in the laboratory at any time.

The glutamine metabolism of several species has been investigated and it has been found that seedlings of the common squash become notably enriched in glutamine when sprouted in darkness. This confirms observations of Schulze made many years ago. Unfortunately, however, the isolation of glutamine in pure form from this material has turned out to be unexpectedly difficult. This problem is receiving continued attention.

Methods of Determining Histidine

The development of an analytical method to determine the proportion of histidine yielded by proteins has been continued. With minor modification, the method that has previously been applied to the histidine-rich blood protein hemoglobin has been found applicable to the case of proteins of low histidine content.

The present purpose is to establish the histidine content of a number of common proteins in order to furnish fundamental data for comparison. Modern amino acid research is tending inevitably in the direction of the development of methods that can be applied to very small quantities of protein. This arises from the fact that although many protein hormones and enzymes can be prepared today in pure crystalline form, the total amount available at any one time is usually small when laboratory methods only are applied because of the great expense and difficulty of the preparation. A well known example is the case of insulin. The ultimate aim of amino acid analysis is the attempt to discover the nature of the unique chemical structures in these rare proteins to which their high physiological activity may be due. Micro-

analytical methods only can be applied to them. But the accuracy of micro-analytical methods must be established before the results they yield are acceptable. Thus it is essential to provide standards for comparison by methods of demonstrated accuracy, so that control of micro-methods shall be possible. It is this phase of the general problem of amino acid analysis concerning which the new method for the determination of histidine is designed to provide information.

Plant Metabolism—Organic Acids

The general problem of the metabolism of the organic acids of plants involves both qualitative and quantitative studies of a variety of plant tissues. The observation that optically active isocitric acid, a substance so rare that samples have been hitherto available in only one or two laboratories in the world, makes up about 11 per cent of the dry weight of the leaves of the common plant *Bryophyllum calycinum* was reported last year. Attention has accordingly been paid to the acid composition of allied species and especially to the accumulation of substantial quantities of leaves for the preparation of this substance in amounts that will permit a detailed study of its properties. In addition, a series of experiments designed to establish the major factors concerned with the metabolism of isocitric acid in *Bryophyllum* leaves has been planned and in part completed. Reports on this material may, however, be delayed until normal conditions in the laboratory have been reestablished.

Standardizing the Rat Colony

A summary has been made of the growth and reproductive performance of rats of the Experiment Station colony in recent years in comparison with similar surveys made previously. An examination of the colony at the present time was prompted in part by reports from other laboratories that indicated poor breeding records which might be attributed to the difficulty of maintaining normal food supplies for the stock colonies.

Our records over a long period indicated that fluctuations in growth and in reproductive performance may be expected and are not necessarily associated with any change in food supply. Smith, Anderson and Hubbell (Bulletin 406) reported a marked decline in fertility in the third generation of rats in one group. In subsequent generations members of this group showed great improvement. A similar observation has been made with the rats of our regular stock colony. In 1938, 84 per cent of mated female rats cast litters and 95 per cent of these litters were weaned. In 1939 the record was essentially the same. However, in 1940, with no change in food or in colony management, only 65 per cent of the mated females cast litters and the number of litters weaned was slightly lower than normal. The records for 1941 and for 1942 were similar to those of 1938 and 1939 and it is evident that reproduction will be "normal" for 1943.

Growth curves for both male and female rats in the breeding stock during 1942-43 agree closely with those reported in 1935. Male rats

were somewhat lighter during the period of growth from 40 days to 110 days. This may be associated with a slight change that has been made in the stock diet during the past year, in order to conserve food.

Citric Acid and Bone Growth

Work on the relation of citric acid to bone calcification has been continued. Reports that have appeared from other laboratories have made it essential to establish normal values for the citric acid content of bones and for other organs and tissues as well. Determinations of citric acid have been made using bones from normal rats of both sexes at weaning and for several other weight groups. From approximately 250 analyses thus far completed it is evident that there are wide variations in citric acid content of bones of animals of the same weight, age and dietary history.

BIOMETRY

Observations in agricultural research are subject to the unavoidable variations of living plants and animals and their environment. Quantitative results must be evaluated against the background of this variation. The earlier an investigator can identify and characterize those factors which are significant, the more efficiently he can conduct his research. In the past decade new methods for coping with the problem have become of inestimable value to the investigator, but their complexity calls for the aid of a specialist. For this purpose, Dr. C. I. Bliss was brought to the Station in 1940 on a part-time basis as consulting biometrician. His aid has been sought by staff members in all departments to the benefit of the quality of our research. In July he was appointed to the newly-established position of Station Biometrician, which at present continues on a part-time basis.

The duties of Station Biometrician also include research for developing and improving techniques. During 1943 attention was centered on the design and analysis of experiments with insecticides and fungicides based on the relation between dosage and effect. In February a conference of phytopathologists, entomologists and biometricians was held in Columbus to discuss collaborative studies in this field with special reference to the conservation of war-scarce materials. A mimeographed statement on the research methods discussed at the conference was prepared at the Station and distributed widely to various investigators on request. Methods of statistical analysis especially adapted for this type of research have been developed from a study of data submitted by entomologists and phytopathologists at the Station. When they have been tested on further experiments, they will be described in a Station bulletin.

THE LIBRARY

The Station Library now contains 27,400 volumes, largely bound journals and bulletins. Some 90 scientific journals are received regularly, in addition to 20 agricultural papers.

During the year there were the following additions:

U. S. Department of Agriculture publications	573
State Agricultural Experiment Station publications	1,306
Scientific and agricultural domestic and foreign journals	1,464
Single books	82
Total	3,425

Within its field, the Station has an unusually good collection, some of the older journals being rare.

A film reader makes possible the use of the film service now provided by many large libraries.

LIST OF PROJECTS

active in 1943-44

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of vitamin D supplements for poultry feeds.)
3. Inspection of foods and drugs. (Including biological assays of vitamin D milk.)
4. Calibration of Babcock glassware and thermometers.
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies on analytical methods.
9. Examination of biological specimens in connection with suspected poisoning of livestock.

(Nos. 2, 3, 4 and 5 are in coöperation with the Dairy and Food Commissioner.)

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the chemical composition of plant tissues with special reference to the changes that occur during culture under various conditions, and to the metabolism of the various components. The development of methods suitable for the accurate determination of the components of plant tissues.
   e. Investigation of the organic acids of plants with special reference to their detection, analytical determination and to their metabolism.
2. Protein chemistry.
   Investigation of the properties of proteins and amino acids with special reference to the development of methods for their preparation and analytical determination.
3. Nutrition investigations.
   Investigations of the relation of certain constituents of the diet, especially the mineral salts, to growth.

Entomology

9. Insect survey of Connecticut.
17. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. of Agr.)
31. Studies on the biology and control of the European pine shoot moth.
37. Substitutes for lead arsenate in orchard sprays in apple maggot control.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury.
40. Studies on the control of the European corn borer. (In coöperation with the U. S. Dept. of Agr.)
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
49. Adhesives for standard spray mixtures.
51. Soil and grassland insect investigations.
52. Study of wireworm injury to potatoes and tobacco.
53. Rodent control. (In coöperation with the U. S. Fish and Wildlife Service.)
55. The biology and control of *Calomycterus setarius* Roelofs.
56. Studies of dusts. (In coöperation with the Dept. of Plant Pathology and Botany.)
57. The biology and control of Comstock's mealybug on pears and apples.
58. Investigations of diseases affecting scarabaeid larvae.
59. The biology and control of the dogwood borer.
60. The biology of the codling moth in Connecticut.

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In coöperation with the U. S. Dept. Agr.)
13. Inspection of apiaries.
19. European corn borer and Japanese beetle inspection. (In coöperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the oriental fruit moth. (In coöperation with the Conn. Pomological Society.)
29. Dutch elm disease control. (In coöperation with the U. S. Dept. Agr.)

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
   a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations, as to growth and habits.
   b. Methods of management for those species that have survived.
   c. The properties of the wood of several of the important species. (In coöperation with the Yale Forestry School.)
6. Studies of forest plantations throughout the State.
   a. Growth and yield of several species in relation to site. (The present studies are on red pine, in coöperation with the State Forester and the Yale Forestry School.)
12. The utilization of native woods. (In coöperation with the State Forester, State Highway Dept., Conn. Forest & Park Assoc., Yale Forestry School, and U. S. Forestry Service.)
   c. The use of hogged wood as a fuel.
   d. Problems involved in the combustion of wood. (In coöperation with the Dept. of Mech. Eng., Yale University.)

Control and Service

7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)

Genetics (Plant Breeding)

1. A genetic and cytological study of hereditary characters in plants.
2. The effect of inbreeding and crossing upon seed and vegetatively propagated plants.
3. Methods for the improvement of naturally cross-fertilized plants by selection in inbred lines.
4. Methods for the improvement of naturally self-fertilized plants.
5. A genetic and physiological study of variation and the effects of selection in vegetables and fruits

Plant Pathology and Botany

5. Plant disease survey of Connecticut.
20. Diseases of shade trees.
27. The Dutch elm disease and related diseases.
28. Studies on the identification of apple varieties by seed characters. (Inactive)
30. Diseases of vegetable crops and their control.
   a. Downy mildew of muskmelons and cucumbers.
   b. Defoliation and related diseases of tomatoes.
   d. Wilt diseases of tomatoes and eggplant.
31. Investigation of the X-disease of peach.
33. Diseases of ornamental plants.
   Rose diseases—powdery mildew, black spot.
34. Fungicides, new and old.
35. Apple spraying.
36. Antidoting phytotoxins and viruses by chemotherapy.
37. Root rot diseases of plants.

Control and Service

12. Seed testing. (In coöperation with the Commissioner of Agriculture.)
25. Spray service. (In coöperation with Extension Service, University of Conn.)

Soils

3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4. The relation of soil conditions to growth and composition of natural and planted forests.
5. Lysimeter studies of the drainage losses and other changes that occur in soils under heavy fertilization as practised for tobacco and vegetables.
7. The improvement of the nutritional status of unproductive forest soils.
8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
9. The evaluation of various soil factors in terms of land use and types of farming.
10. Nitrogen relationships in soil maintenance by green manures in vegetable cropping systems.

Tobacco Substation

1. Fertilizer experiments.
   - bb. The relative efficiency of nitrogen from castor pomace, soybean oil meal and cottonseed meal.
   - e. Comparison of various single sources of nitrogen.
   - fa. Comparison of sources of phosphorus.
   - qa. Fertilizer placement tests.
   - r. Plowing under the fertilizer.
4. Tobacco nutrition studies.
   - b. Boron experiments.
   - d. Symptoms of food element deficiency.
   - h. Ammonification and nitrification of fertilizer materials.

7aa. Improvement of Shade tobacco by selection and breeding. (With Genetics Dept. and in coöperation with the Shade Tobacco Growers Agricultural Association, Inc.)

17aa. Study of tobacco pigments.

17b. The study of the cause of black Shade tobacco.

19. Investigation of various tobacco diseases.
   - a. Damping-off.
   - c. Pole rot.
   - e. Breeding for mosaic resistant Broadleaf.
   - f. Control of downy mildew.
   - i. Sclerotinia and Botrytis diseases of tobacco.

20. The biology and control of insects that attack tobacco. (See also Entomology No. 52.)
22. Irrigation of tobacco.
26. Chlorpicrin for sterilization of tobacco bed soil.
31. Breeding for low nicotine content of leaf.

PUBLICATIONS

July, 1942 to July, 1943

BULLETINS OF THE STATION

No. 459. Commercial Feeding Stuffs. Report of Inspection, 1941. E. M. Bailey.

No. 460. Report on Food Products and Drugs for 1941. E. M. Bailey.

No. 461. Connecticut State Entomologist. Forty-first Report, 1941. R. B. Friend.

No. 462. Investigations on the Control of the European Corn Borer. Raimon L. Beard and Neely Turner.

No. 463. A Wood-Burning Conversion Unit for Household Furnaces. Henry W. Hicock, A. Richard Olson and Lauren E. Seeley.

No. 464. The Rainbow Forest Plantations. Report of Progress, 1942. Henry W. Hicock.

No. 465. Cytological and Genetic Studies of Sterility in Inbred and Hybrid Maize. Frances J. Clark.

No. 466. Drainage Water Losses from A Sandy Soil as Affected by Cropping and Cover Crops. Windsor Lysimeter Series C. M. F. Morgan, H. G. M. Jacobson and S. B. LeCompte, Jr.

No. 467. Commercial Fertilizers. Report for 1942. E. M. Bailey.

No. 468. Annual Report for the Year Ending October 31, 1942.

No. 469. Tobacco Substation at Windsor. Report for 1942. P. J. Anderson, T. R. Swanback and S. B. LeCompte, Jr.

No. 470. Notes on Livestock Poisoning in Connecticut. C. E. Shepard, E. M. Bailey and D. C. Walden.

No. 471. The Significance of Growth Stages of Sweet Corn as Related to Infestation by the European Corn Borer. Raimon L. Beard.

No. 472. Connecticut State Entomologist. Forty-Second Report, 1942. R. B. Friend.

No. 473. Commercial Feeding Stuffs. Report on Inspection, 1942. E. M. Bailey.

CIRCULARS OF THE STATION

No. 154. How Connecticut Nurserymen Can Aid in Food Production.

No. 155. Controlling Pests of War Gardens. Neely Turner and James G. Horsfall.

No. 156. Growing Potatoes in War Time.

No. 157. Control of the Japanese Beetle. J. Peter Johnson.

JOURNAL PAPERS

Bliss, C. I., and Cattell, McKeen. Biological assay. Annual Review of Physiology, 5:479-539. 1943.

Bliss, C. I., and Dearborn, R. B. The efficiency of lattice squares in corn selection tests in New England and Pennsylvania. Proc. Amer. Soc. Hort. Science, 41:324-342. 1942.

Bliss, C. I., and Moore, William. A method for determining insecticidal effectiveness using *Aphis rumicis* and certain organic compounds. Jour. Econ. Ent., **35**:544. 1942.

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Curtis, Lawrence C. The effect of storage on the betanin and sucrose content of garden beets (*Beta vulgaris*) and its importance in a breeding program with this crop. Amer. Soc. Hort. Sci., **41**:370-374. 1942.

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Fisher, H. J. Xanthone 2,7-dinitrile. Jour. Amer. Chem. Soc., **65**:991. 1943.

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Hubbell, R. B., Vickery, H. B., and Nolan, L. S. Cucurbit seed globulins. II. Use as substitutes for edestin in experimental diets. Jour. Nutrition, **25**:99-101. 1943.

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PUCHER, G. W., and VICKERY, H. B. On the identity of the so-called crassulacean malic acid with isocitric acid. Jour. Biol. Chem., **145**:525-532. 1942.

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All of which is respectfully submitted.

WILLIAM L. SLATE,

Director.

REPORT OF THE TREASURER

July 1, 1942 to June 30, 1943

Income

STATE APPROPRIATIONS:	
Regular	$243,642.00
Special:	
Construction and Plant Improvements	2,638.42
FEED FEES	17,000.00
FERTILIZER FEES	12,720.00
MISCELLANEOUS	262.64
TRUST FUNDS AND GRANTS	22,807.89
FEDERAL APPROPRIATIONS:	
Adams	7,500.00
Hatch	7,500.00
Bankhead-Jones	11,253.66
Purnell	30,000.00
	$355,324.61
UNEXPENDED BALANCE	47,921.64
NET INCOME	$307,402.97

July 1, 1942 to June 30, 1943

Expenditures

	Personal Services	Contractual Services	Supplies and Materials	Capital Outlay	Totals
STATE APPROPRIATIONS:					
Station General Fund	$75,689.08	5,108.73	8,149.07	2,180.90	91,127.78
Bee Diseases (Inspection)	1,740.00	1,038.80	6.50	.....	2,785.30
Food and Drug Analyses	7,782.50	308.50	532.03	162.60	8,785.63
Gypsy Moth Suppression	23,968.01	1,297.91	808.11	35.60	26,109.63
Insect Pest Control and Research	50,975.85	2,318.34	1,749.62	555.56	55,599.37
Tobacco Substation	16,151.33	464.49	1,410.39	850.59	18,876.80
White Pine Blister Rust Control	4,082.70	536.39	209.20	.....	4,828.29
Construction and Plant Improvements	.....	.....	.....	2,155.85	2,155.85
FEDERAL FUNDS	49,036.95	1,803.55	2,727.32	2,087.47	55,655.29
FEED INSPECTION	15,119.20	457.14	616.64	81.25	16,274.23
FERTILIZER INSPECTION	11,013.07	455.87	551.92	122.80	12,143.66
TRUST FUNDS AND GRANTS	10,763.66	296.05	1,681.32	320.11	13,061.14
NET EXPENDITURES	$266,322.35	14,085.77	18,442.12	8,552.73	307,402.97